Invacare® Tornado

SERVICE MANUAL

These instructions contain information about:

Troubleshooting

Repair

Edition: 03.2004

General information

These repair instructions contain all the information necessary for maintenance and overhaul of the wheelchair.

- All maintenance and overhaul work must be carried out in accordance with these repair instructions.
- Please observe all safety instructions.
- Information about operation or about general maintenance and care work should be taken from the wheelchair Operating Manual.
- You can find information about ordering spare parts in the spare parts catalogue.
- Use only genuine Invacare® spare parts. Using parts from any other source will void the warranty!
- We reserve the right to make any alterations on the grounds of technical improvements.
- The wheelchair may only be maintained and overhauled by qualified personnel.
- The minimum requirement for service technicians is relevant training, such as in the cycle or orthopaedic mechanics fields, or suitably long-term job experience.
  - Experience and knowledge of electrical measuring devices (Multimeter) is also a requirement.
  - Special Invacare training sessions are recommended.
- Alterations to the wheelchair which occur as a result of incorrectly or improperly executed maintenance or overhaul work lead to the exclusion of all liability on the part of INVACARE.
- If you have any problems or questions please contact INVACARE SERVICE:

Invacare® Deutschland GmbH
Kleiststraße 49
32457 Porta Westfalica
Deutschland
☎ (Technische Hotline): 01 80 - 5 26 22 64
Fax (Technische Hotline): 01 80 - 5 26 22 75

Invacare® A/S
Sdr. Ringvej 39
2605 Brøndby
Danmark
☎ (Kundeservice): +45 - (0) 3690 0000
Fax (Kundeservice): +45 - (0) 3690 0001

Invacare®, SA
c/ Areny, s/n
Poligon Industrial de Celrà
17460 Celrà (Girona)
ESPAÑA
☎ : +34 - (0) 972 - 49 32 00
Fax: +34 - (0) 972 - 49 32 20

Invacare® POIRIER
Les Roches
F-37230 Fondettes
France
☎ (Service Après-Vente):+33 - (0) 2 47 - 62 64 66
Fax (Service Après-Vente):+33 - (0) 2 47 - 42 12 24

Invacare® Ltd
South Road
Bridgend
Mid Glamorgan - CF31-3PY
United Kingdom
☎ (Customer Service): +44 - (0) 1656 - 647 327
Fax (Customer Service): +44 - (0) 1656 - 649 016

Invacare Mecc San s.r.l.
Via Dei Pini, 62
I - 36016 Thiene (VI)
ITALIA
☎: +39 - (0) 445-380059
Fax: +39 - (0) 445-380034

Invacare® AS
Grensesvingen 9
0603 Oslo
Norge
☎ (Kundeservice): +47 - 22 57 95 10
Fax (Kundeservice): +47 - 22 57 95 01

Invacare® B.V.
Celsiusstraat 46
NL-6716 BZ Ede
The Netherlands
☎ : +31 - (0) 318 - 69 57 57
Fax: +31 - (0) 318 - 69 57 58

Invacare® PORTUGAL Lda
Rua Senhora de Campanhã, 105
4369-001 Porto
PORTUGAL
☎ : +351-225105946
Fax: +351-225105739

Invacare® AB
Fagerstagatan 9
163 91 Spånga
Sverige
☎ (Kundtjänst): +46 - (0) 8 761 70 90
Fax (Kundtjänst): +46 - (0) 8 761 81 08
sweden@invacare.com

Service
Invacare
JÄRFÄLLA
☎: +46 - (0) 8 – 621 08 44
Fax: +46 - (0) 8 – 621 08 45
Invacare.jarfalla@.swipnet.se

MÖLNDAL
☎: +46 - (0) 31 – 86 36 00
Fax: +46 - (0) 31 – 86 36 06
invacare.goteborg@swipnet.se

LANDSKRONA
☎: +46 - (0) 418 – 285 40
Fax: +46 - (0) 418 – 180 89
invacare.la@swipnet.se

OSKARSHAMN
☎: +46 - (0) 491 – 101 40
Fax: +46 - (0) 491 – 101 80
invacare.O-hamn@swipnet.se

Invacare® n.v.
Autobaan 14
8210 Loppem (Brugge)
BELGIUM
☎: +32 (50) 831010
Fax: +32 (50) 831011

Notes on transport

- If the wheelchair has to be shipped back to the manufacturer for major repairs, you should always use the original packaging for transport.
- You should also include as accurate a fault description as possible.

The following symbols are used in these repair instructions:

Note:

This symbol identifies general information which indicate special points or simplifications in dismantling / reassembly.

CAUTION:

it is imperative that you observe any >safety instructions< identified with this symbol.

This symbol identifies service work.

Contents

1 SAFETY AND ASSEMBLY INSTRUCTIONS 7

1.1 Before any inspection or repair work 7

1.2 During dismantling/reassembly 7

1.3 After completion of work / before operating the wheelchair: 8

2 TOOL LIST 9

2.1 Tightening torques and Loctite 10

3 LAYOUT OF COMPONENTS AND MODULES 11

4 SERVICE PLAN (1X ANNUALLY) 13

5 TROUBLESHOOTING THE TORNADO 15

5.1 Troubleshooting the Tornado with ACS 15
5.1.1 Diagnosing driving faults 15
5.1.2 Diagnosing problems with electric actuators 17
5.1.3 REM24 Error Codes and Diagnostic Codes 18

5.2 Troubleshooting the Invacare® Tornado with Shark Remote 20
5.2.1 Diagnosing driving faults 20
5.2.2 Shark Error Codes and Diagnostic Codes 22

6 REPAIR WORK 24

6.1 Replacing the drive motors 24

6.2 Replacing components of the ACS or Shark electronics 27

6.3 Replacing batteries 29

6.4 Replacing the main fuse 34

6.5 Checking the cables 36

6.6 Replacing the remote 38

6.7 Testing an actuator motor 39

6.8 Adjusting and replacing the speed reduction switch 40

6.9 Replacing the steering head bearings on the front or rear castor wheels 41
6.9.1 Front Castor Wheels 41
6.9.2 Rear Castor Wheels 43

6.10 Replacing the Anti-Dive Spring and/or its plastic guides 45

6.11 Repairing a flat tyre 48

6.12 Replacing a drive wheel 50

1 Safety and assembly instructions

These safety instructions are intended to prevent accidents during work and it is imperative that they are observed.

1.1 Before any inspection or repair work

- Read and observe this repair manual and the associated operating manual.
- Observe the minimum requirements for carrying out the work (see chapter entitled "General information").

Caution:

- Please note the heavy weight of some components. This applies especially to removal of drive units and batteries.
- The wheelchair must be switched off before removal of voltage-carrying components. To do this, disconnect the batteries or remove them.
- When making measurements on voltage-carrying components, avoid short-circuiting the contacts. **Danger of fire and combustion !**
- Use only undamaged tools in good condition.

1.2 During dismantling/reassembly

- Mark all current settings for the wheelchair (seat, armrests, backrest etc.), and the cable connecting plugs associated, before any removals. This makes reassembly easier.

Caution:

- Prop up the lifted wheelchair with appropriate supports before starting the disassembly or assembly.
- Never use standard nuts instead of self-locking nuts.
- Always use correctly dimensioned washers or spacers.

Note:

- All plugs are fitted with mechanical safety devices which prevent release of the connecting plugs during operation.
- To release the connecting plugs the safety devices must be pressed in.
- When reassembling ensure that these safety devices are correctly engaged.
- Cable binders which have been cut off during disassembly should be replaced by new ones during reassembly.

1.3 After completion of work / before operating the wheelchair:

Caution:

- Check all fixings for tight fit.
- Check all parts for correct interlocking.
- Only operate wheelchair with correct tyre pressure (2.5 bar).
- Check electrical components for correct functioning, incorrect polarity of cables can result in damage to the electronics.

As a last check, always carry out a test-drive.

2 Tool list

You will need a standard tool set with at least the following:

- set of open and ring spanners (6 – 24 mm)
- set of Allen keys (1.5 - 10 mm)
- torque wrench (commercial)
- socket spanner set
- set of screwdrivers (0.5 - 1.6 mm)
- oblique pliers
- flat-nosed pliers
- circlip pliers
- pointed pliers
- cable lug pliers
- wooden or plastic hammer
- tyre repair kit (commercial)
- tyre pressure indicator
- valve removal tool
- wheel bearing puller
- multimeter with probes and various cable clips
- soldering iron 30 W
- front wheel hub puller (available from INVACARE Service)
- circlip pliers for star lock caps (commercially available, make Tigtemeyer)
- pop riveting tool
- stepped mandrel

2.1 Tightening torques and Loctite

The tightening torques stated in the following table are dependent on the thread diameters for the nuts and bolts for which no special values are determined. All values apply to dry and grease-free threads.

		Thread diameter					
	Unit	M5	M6	M8	M10	M12	M16
Torque	Nm	3.4-4.9	5.9-7.8	14-19	25-34	44-61	115-155
	mkp	0.35-0.80	0.60-0.80	1.4-1.9	2.6-3.5	4.5-6.2	11.5-16
Spanner width	mm	8	10	13	17	19	24
For comparison!							
Lever arm on ring spanner DIN 838	mm	180	190	215	240	265	285
Therefore achievable torque	Nm	56	63	70	84	101	125

Caution*:* **All other nuts or plastic connectors not noted here must be tightened FINGERTIGHT!**

Caution: **Tighten the front wheel on the castor fork fingertight and without play! Apply micro-encapsulated adhesive to the thread! INVACARE uses VIBRATITE VC3 for this purpose.**

Caution: **When reassembling the front wheel fork in the head tube, ensure that the fork is free-moving! The union should be tightened fingertight, and should not result in stiff movement of the head tube bearing.**

3 Layout of components and modules

The following image shows the Tornado from above rear, with the seat lifter raised and the rear cowling removed.

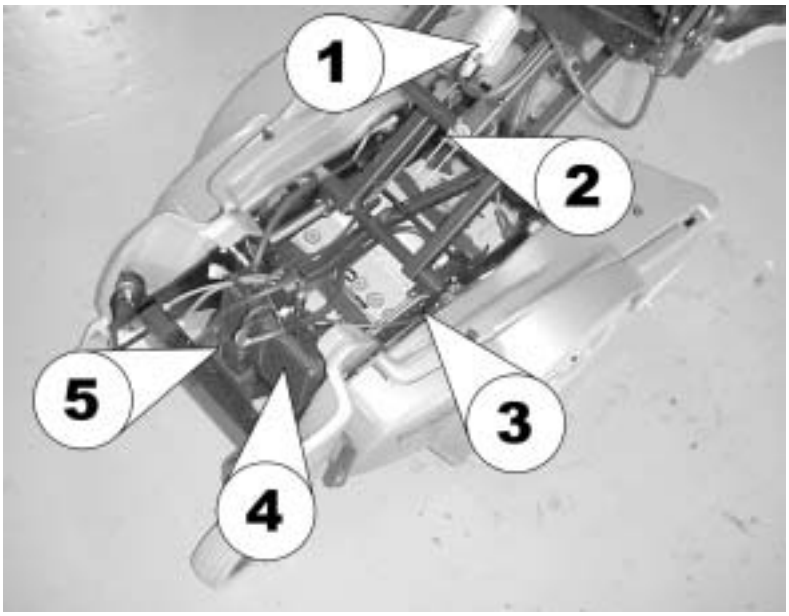
1 Seat tilt actuator

2 Seat-frame / rear cowling anti-collision switch

3 Speed-reduction switch

4 Power module

5 CLAM (Combined Light and Actuator Module)



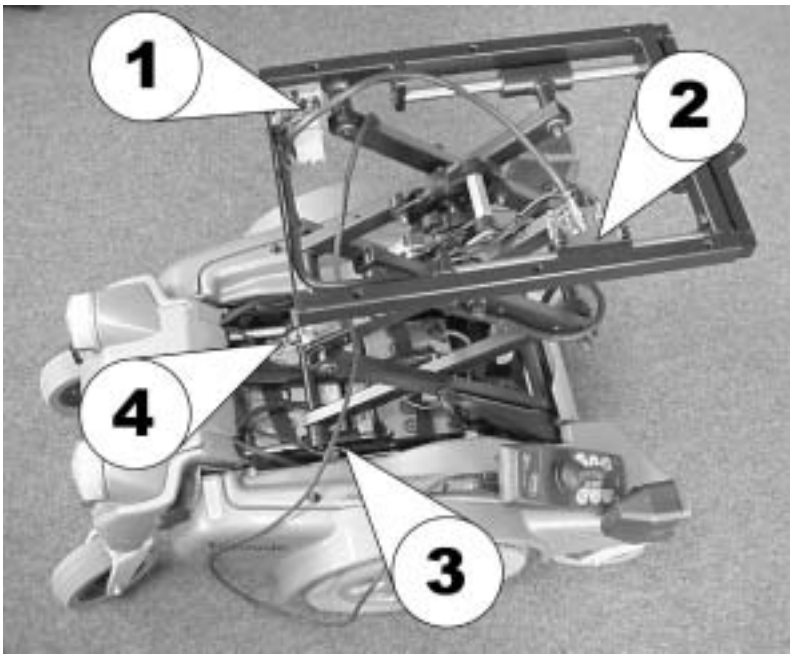
The following image shows the Tornado from above, with the lifter raised and the seat removed

1 Cable loom connectors

2 Seat lifter and tilt actuator end-position switch

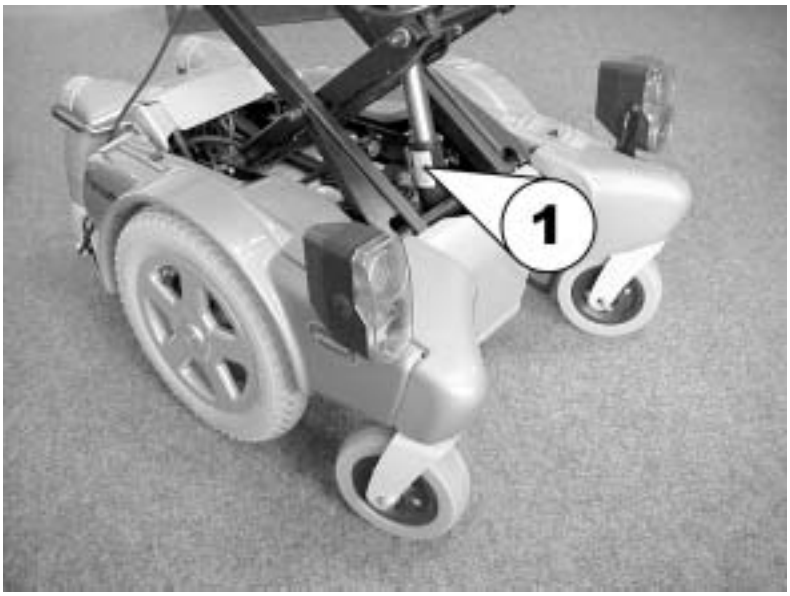
3 Speed-reduction switch

4 Seat-frame / rear cowling anti-collision switch



The following image shows the Tornado from the front right, with the lifter raised

1 Lifter actuator



4 Service plan (1x annually)

Component	Check	Action	Notes	✓
Armrests and side panels	• Armrest damage and fastening • Side panel damage and fixing	♥ Tighten screws, replace padding if damaged ♥ Tighten screws, replace side panels if damaged		
Seat unit / seat angle adjustment	• Cushion • Check seat angle adjustment	♥ Replace covers / upholstery if damaged ♥ Replace parts if damaged		
Backrest unit mechanical **Backrest unit electrical**	• Damage and seams • Fixings • Check cabling • Check function	♥ Replace parts if damaged ♥ Tighten screws ♥ Replace cable or motor if necessary		
Frame (chassis) / battery box	• Check fixings, welded seams and battery box	♥ Tighten screws, replace components		
Wheel suspension and wheels	• Check drive wheels for tight fit and side play	♥ Adjust, replace wheel hubs	See "Replacing a drive wheel" on page 50	
	• Check steering wheels for tight fit, float and side play	♥ Replace wheels, wheel fork or wheel bearings	See "Replacing the steering head bearings on the front or rear castor wheels" on page 41	
	• Check pneumatic tyres on the drive wheels	♥ Repair or replace if damaged	See "Repairing a flat tyre" on page 48	
Drive units, disengager	• Check functions in drive and push modes • Check disengager	♥ Replace motor if necessary ♥ Tighten screws / nuts, adjust or replace if necessary		
Footrests	• Check welded seams, interlocking, screws, footplates	♥ Tighten, replace if necessary		
Electrical footrests	• Check cabling • Check contacts • Check functions	♥ Replace cable if necessary		
Lighting	• Check cabling • Check function	♥ Replace bulbs or cables if necessary		

Component	Check	Action	Notes	✓
Batteries	• Check batteries for damage	♥ Replace batteries if necessary	See "Replacing batteries" on page 29	
	• Check battery charge	♥ Charge batteries	See User Manual	
	• Check contacts and terminals for corrosion	♥ Clean contacts and terminals	See "Replacing batteries" on page 29 for Safety Information on working with batteries	
Remote / electronics	• Remote, status display blinking • Fixing • Cable, connecting plug • Joystick function • Power supply	♥ Evaluate flash code ♥ Tighten, replace ♥ Replace ♥ Replace joystick ♥ Replace cable, connector plug or console		
Walking Beam	• Check spring for damage • Check that the bolts that hold the spring guides have become loosened	♥ Replace if damaged ♥ Replace spring guides if damaged	See "Replacing the Anti-Dive Spring and/or its plastic guides" on page 45	
Lifter	• Check correct function • Check function of the Stability Lock	♥ Repair if necessary		

5 Troubleshooting the Tornado

5.1 Troubleshooting the Tornado with ACS

If a problem occurs with the wheelchair, then please proceed as follows:

- Identify the possible cause of the fault by using the troubleshooting tables below.
- Check the Status Display on the remote. Identify the error code if it is flashing.
- Perform the necessary checks and repairs as recommended in the table below.

5.1.1 Diagnosing driving faults

PROBLEM	OTHER SYMPTOMS	POSSIBLE CAUSE	SOLUTION	REFERENCE
Wheelchair will not drive	Status display on remote lights up normally and does not show an error code	Drive motors may be disengaged	• Engage the drive motors	See User Manual
	Status display on remote does not light up	Batteries may be defective	• Replace the batteries	See "Replacing batteries" on page 29
		Batteries may be completely discharged	• Charge the batteries	See User Manual
		Power supply to the remote may be interrupted	• Check the main fuse	See "Replacing the main fuse" on page 34
			• Check cables between modules for loose connections or damage	See "Checking the cables" on page 36
		Remote may be defective	• Exchange the remote on the wheelchair for a different one to eliminate the possibility that the remote may be the cause.	See "Replacing the remote" on page 38
	Status display on remote is flashing	Various causes	• Identify the error code	See "REM24 Error Codes and Diagnostic Codes" on page 18

PROBLEM	OTHER SYMPTOMS	POSSIBLE CAUSE	SOLUTION	REFERENCE
	Status display on remote flashes 2x, drive mode display shows "U"	Speed reduction switch on the lifter may be defective or disconnected	• Replace cable or switch	See "Adjusting and replacing the speed reduction switch" on page 40
Wheelchair does not drive smoothly	None	Batteries may be defective (voltage not stable)	• Replace the batteries	See "Replacing batteries" on page 29
		Drive motor(s) may be defective	• Replace the drive motor(s)	See "Replacing the drive motors" on page 24
Batteries cannot be charged	None	Batteries may be defective	• Replace the batteries	See "Replacing batteries" on page 29
	LEDs on the charger are flashing	Charger may be defective	• Replace the charger	See User Manual of the charger
Wheelchair drives too slowly	Status display on remote flashes 2x, drive mode display shows "U"	Seat lifter is not in driving position (either too high or too low), and has activated the automatic speed reduction.	• Return seat lifter to driving position	See User Manual
		Speed-reduction micro-switch on the seat lifter may be badly adjusted	• Adjust the micro-switch	See "Adjusting and replacing the speed reduction switch" on page 40
	None	Remote may be defective	• Replace the remote	See "Replacing the remote" on page 38
		Batteries may be defective	• Replace the batteries	See "Replacing batteries" on page 29

5.1.2 Diagnosing problems with electric actuators

In case an electric actuator will not function, identify the source of the problem using the following table:

PROBLEM	OTHER SYMPTOMS	POSSIBLE CAUSE	SOLUTION	REFERENCE
Electric Actuator does not function	Remote displays a flashing "E", status diode on the CLAM does not go out, even if the remote is switched off or disconnected	CLAM is defective	• Replace the CLAM	See "Replacing components of the ACS or Shark electronics" on page 27
	None	Cable may be disconnected or damaged	• Check that the cable is not disconnected or damaged. If necessary, replace the cable	See "Checking the cables" on page 36
		Electric actuator may be defective	• Test the actuator	See "Testing an actuator motor" on page 39
		Remote may be defective	• Exchange the remote on the wheelchair for a different one to eliminate the possibility that the remote may be the cause.	See "Replacing the remote" on page 38

5.1.3 REM24 Error Codes and Diagnostic Codes

The drive electronics are capable of rectifying some errors automatically. In this case the status display will cease to flash. Please switch the remote on and off several times. Wait approx. 5 seconds each time before switching the remote on again. If this does not rectify the error, locate the error using the flash codes shown below.

Flash code:	Meaning:	Solution:	Notes
1 x flash	Module defective	Replace defective module	See "Replacing components of the ACS or Shark electronics" on page 27
2 x flashes	Accessory error (e.g. actuator short-circuit)	• Check accessory connections, check accessories	See "Testing an actuator motor" on page 39
	Lifter raised or lowered too far (seat not at driving height)	• If lifter is raised, lower in stages until the status display stops flashing. If lowered too far, raise lifter in stages until the status display stops flashing. If at all possible, only drive when the seat is at driving height.	See User Manual
3 x flashes	Fault in right-hand motor. Connection loose/defective or motor defective	• Check connecting plugs • Check motor	See "Checking the cables" on page 36 See "Replacing the drive motors" on page 24
4 x flashes	Fault in left-hand motor. Connection loose/defective or motor defective	• Check connecting plugs • Check motor	See "Checking the cables" on page 36 See "Replacing the drive motors" on page 24
5 x flashes	Fault/brake fault on right-hand motor. Connection loose/defective or motor defective	• Check connecting plugs	See "Checking the cables" on page 36 See "Replacing the drive motors" on page 24
6 x flashes	Fault/brake fault on left-hand motor. Connection loose/defective or motor defective.	• Check connecting plugs	See "Checking the cables" on page 36 See "Replacing the drive motors" on page 24

Flash code:	Meaning:	Solution:	Notes
7 x flashes	Completely discharge battery	• Pre-charge battery	See User Manual
8 x flashes	Battery voltage too high	• Switch lights on to lower battery voltage • Check battery charger	See User Manual of battery charger
9 or 10 x flashes	Faulty data transmission between modules	-	Remove all electronic modules except the Power Module and the Remote. Re-attach modules one by one to determine which one is causing the fault. See "Replacing components of the ACS or Shark electronics" on page 27
11 x flashes	Motors overloaded / overheated	• Switch remote on and off / wait if necessary	-
12 x flashes	Module used has compatibility problems	• Remove incorrect module	See "Replacing components of the ACS or Shark electronics" on page 27

5.2 Troubleshooting the Invacare® Tornado with Shark Remote

If a problem occurs with the wheelchair, then please proceed as follows:

- Identify the possible cause of the fault by using the troubleshooting tables below.
- Check the Status Display on the remote. Identify the error code if it is flashing.
- Perform the necessary checks and repairs as recommended in the table below.

5.2.1 Diagnosing driving faults

PROBLEM	OTHER SYMPTOMS	POSSIBLE CAUSE	SOLUTION	REFERENCE
Wheelchair will not drive	Status display on remote lights up normally and does not show an error code	Drive motors may be disengaged	• Engage the drive motors	See User Manual
	Status display on remote does not light up	Batteries may be defective	• Replace the batteries	See "Replacing batteries" on page 29
		Batteries may be completely discharged	• Charge the batteries	See User Manual
		Power supply to the remote may be interrupted	• Check the main fuse	See "Replacing the main fuse" on page 34
			• Check cables between modules for loose connections or damage	See "Checking the cables" on page 36
		Remote may be defective	• Exchange the remote on the wheelchair for a different one to eliminate the possibility that the remote may be the cause.	See "Replacing the remote" on page 38
	Status display on remote is flashing	Various causes	• Identify the error code	See "Shark Error Codes and Diagnostic Codes" on page 22

PROBLEM	OTHER SYMPTOMS	POSSIBLE CAUSE	SOLUTION	REFERENCE
Wheelchair does not drive smoothly	None	Batteries may be defective (voltage not stable)	• Replace the batteries	See "Replacing batteries" on page 29
		Drive motor(s) may be defective	• Replace the drive motor(s)	See "Replacing the drive motors" on page 24
Batteries cannot be charged	None	Batteries may be defective	• Replace the batteries	See "Replacing batteries" on page 29
	LEDs on the charger are flashing	Charger may be defective	• Replace the charger	See User Manual of the charger
Wheelchair drives too slowly	None	Batteries may be defective	• Replace the batteries	See "Replacing batteries" on page 29

5.2.2 Shark Error Codes and Diagnostic Codes

The drive electronics are capable of rectifying some errors automatically. In this case the status display will cease to flash. Please switch the remote on and off several times. Wait approx. 5 seconds each time before switching the remote on again. If this does not rectify the error, identify the error using the flash codes shown below.

FLASH CODE	Meaning	Solution	Notes
1	User error	• Ensure that the joystick is in the neutral central position (simply release the joystick) and switch on again.	
2	Battery error	• Check battery and supply cable.	See "Checking the cables" on page 36
		• Charge batteries. If you switch the wheelchair off for a few minutes, the batteries can often recharge to such an extent that a short run is still possible. However, you should only do this in an emergency, as this causes the batteries to discharge excessively.	See User Manual
		• Replace batteries	See "Replacing batteries" on page 29
3	Fault on left-hand motor (M2)	• Check motor cable and connecting plugs. • Check motor.	See "Checking the cables" on page 36 See "Replacing the drive motors" on page 24
4	Fault on right-hand motor (M1)	• Check motor cable and connecting plugs. • Check motor.	See "Checking the cables" on page 36 See "Replacing the drive motors" on page 24
5	Error on left-hand (M2) wheel lock	• Check cable and connecting plugs.	See "Checking the cables" on page 36
6	Error on right-hand (M1) wheel lock	• Check cable and connecting plugs.	See "Checking the cables" on page 36
7	Error in Shark remote	• Check remote bus cable and all connecting plugs. • Replace remote.	See "Checking the cables" on page 36 See "Replacing the remote" on page 38

FLASH CODE	Meaning	Solution	Notes
8	Error in Shark power module	• Check all cables and connecting plugs in the Shark system. • Replace power module	See "Checking the cables" on page 36 See "Replacing components of the ACS or Shark electronics" on page 27
9	Communication error in Shark system	• Check all cables and connecting plugs in the Shark system. • Replace remote.	See "Checking the cables" on page 36 See "Replacing the remote" on page 38
10	Unknown error	• Check all cables and connecting plugs.	See "Checking the cables" on page 36
11	Incompatible remote	• The wrong remote type is connected. Ensure that the power module type code matches the remote type code.	See "Replacing the remote" on page 38 See "Replacing components of the ACS or Shark electronics" on page 27

6 Repair Work

6.1 Replacing the drive motors

Find out here how to replace the Tornado drive motors.

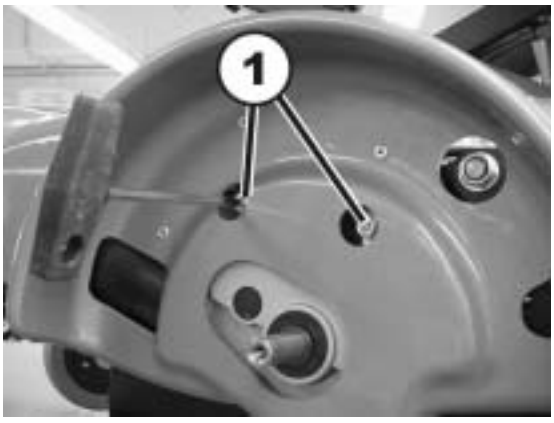
CAUTION! Danger of tipping over and crushing!
- *Secure the vehicle with wedges and a jack-up device to prevent it rolling and tilting, as it tends to do this following removal of a drive wheel.*

Pre-requisites:
- Large screwdriver
- 5mm and 6mm hexagon socket
- Diagonal-nosed cutting pliers
- Material for jacking up the vehicle

Please note
Please pay attention to the plain washers during dismantling. Put small parts aside in such a way that they can be re-fitted in the correct order.

- Jack up the vehicle, for instance by placing a block of wood under the chassis.
- Loosen the wheel nut (1) using a 5mm hexagon socket.
- Remove the Allen screw and the hub cap.
- Pull the complete wheel from the wheel hub.

- Loosen the screws (1) using a 6mm hexagon socket and remove the outer side panelling.

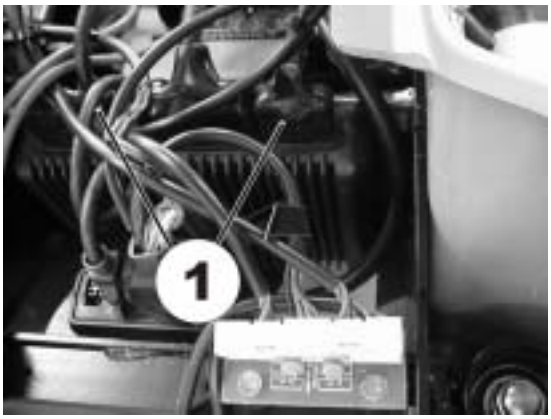


- Loosen the turn-lock fasteners (1) and remove the inner side panelling.

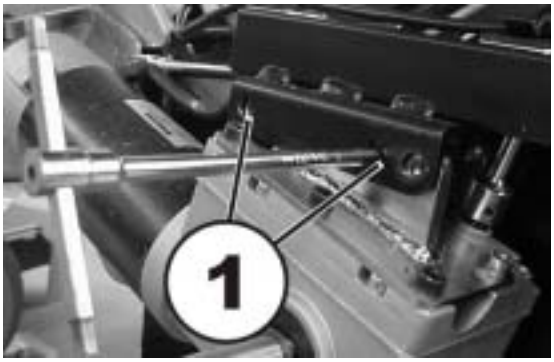
- Remove the securing ring (1) and release the uncoupling rod assembly from the drive unit.

- Open the electronic panelling, pushing the rear side panelling away slightly using a large, flat screwdriver.

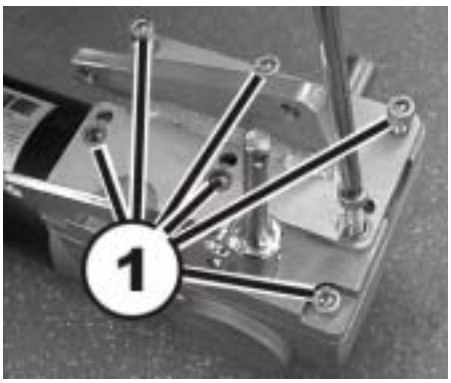
- Pull the motor plug (1) for the right-hand or left-hand drive out of the electronics.



- Secure the drive unit against falling out by placing a wooden block or styrofoam block underneath.
- Insert the hexagon socket (5mm) through the bore and unscrew the rear bolts (1) on the drive suspension.
- Remove the drive unit from the suspension in a downward direction.



- Unscrew the six screws (1) on the bedding plate.



CAUTION! Fire hazard! Cables can be pinched and chafed.

- *Please ensure correct cable layout! The motor cable must be secured on the panelling by means of a plastic ring and may not protrude into the lifter area.*

- The drive unit is installed in reverse order.

6.2 Replacing components of the ACS or Shark electronics

This chapter will explain how to replace the components of either the ACS or the Shark electronic systems on the Tornado.

Requirements:

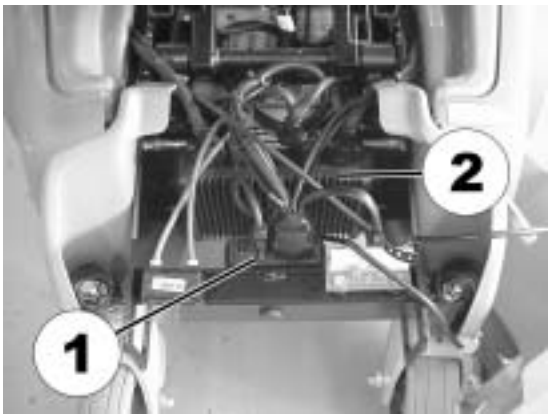
- Large flat-bladed screwdriver
- Phillips screwdriver
- Hexagonal socket head key 4 mm

- Use the flat-bladed screwdriver to carefully pry the plastic cover off, as shown in the picture.

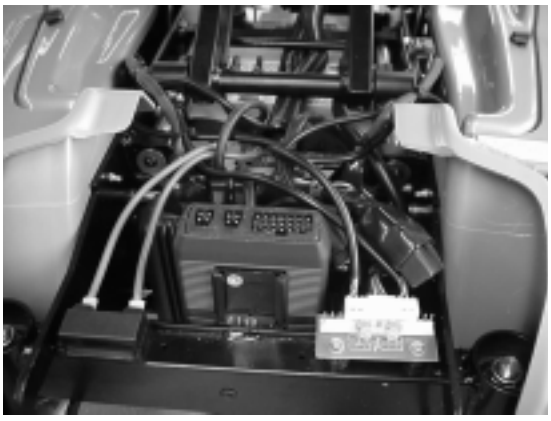
The picture at right shows the positions of the CLAM and the Power Module of the ACS System. The Shark Power Module is located in exactly the same position as it's ACS counterpart.

1) CLAM (or Lighting Module)

2) Power Module (partly hidden by cables)

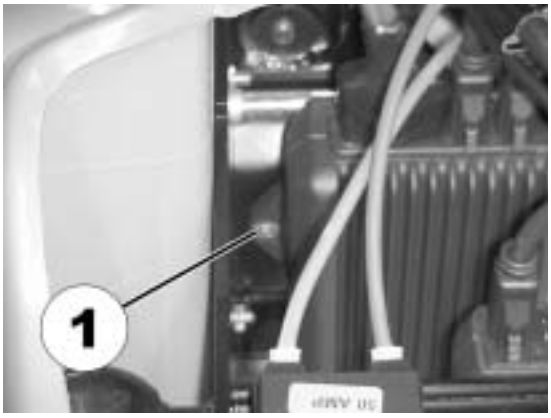


- Remove all electrical connectors from the module that needs to be replaced.



If replacing the Power Module (ACS or Shark):

- Remove the hexagonal socket head screws (1) on both sides of Power Module.
- Pull the Module up and out.



If replacing the CLAM / Lighting Module :

- Detach the CLAM from it's holder by simply pulling it upwards.

- Replace the defective module and re-assemble all components in reverse order.

6.3 Replacing batteries

Find out here how to replace the Tornado batteries.

CAUTION! Risk of chemical burns!
- *Please look out for damaged batteries or ensure that you do not damage the batteries. Leaking acid can cause chemical burns to the skin and eyes.*
- *If acid should come into contact with the skin, rinse immediately using plenty of freshwater.*
- *If acid should get into the eyes, rinse immediately using plenty of fresh water and consult a physician.*

CAUTION! Danger of crushing!
- *Secure the lifter against unintentional folding by using the mechanism intended for this purpose.*
- *Check whether the battery belts are damaged and lift the batteries carefully.*

CAUTION: Risk of fire and burns if battery poles are short-circuited!
- *When replacing the batteries the battery poles MUST NOT come into contact with metal parts of the wheelchair causing bridging!*
- *Be sure to replace the battery pole caps after the batteries have been replaced!*

CAUTION! Environmental contamination!
- *Used batteries should not be disposed of with domestic waste or outdoors. Please dispose of the batteries professionally by giving them to your local harmful substance point of acceptance.*

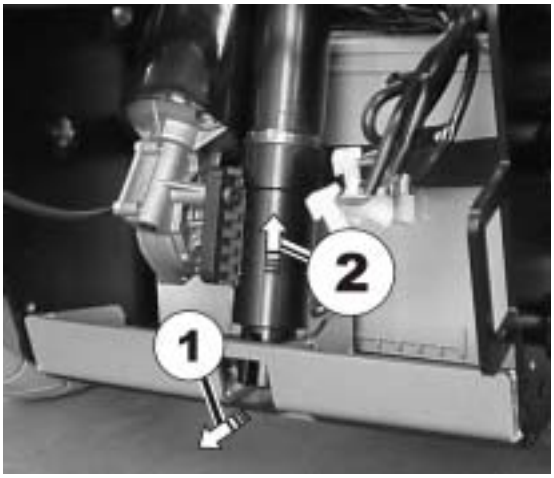
Pre-requisites:
- 11mm open-jawed wrench
- 5mm and 6mm hexagon socket
- Diagonal-nosed cutting pliers
- Rubber hammer
- Water-resistant marker
- Cable binder
- Replacement battery (ies)
- Optional new battery belts
- Large flat screwdriver

Please note
It is easier to carry out a few work steps with the assistance of another person, in particular when lifting the lifter and unlocking the retaining mechanism.

- Move the lifter to the uppermost position.
- Raise the lifter just a little more so that the retaining mechanism (1) locks into place.
- Check whether the retaining mechanism (1) is fully locked into place.
- Move the regulating motor to the lowest position. The regulating motor slides out of the upper guiding device.

- Use a 5mm or 6mm hexagon socket to unscrew the screws (1) and (2) on both sides of the vehicle.
- Remove the front panelling to the front.

- Open the plug-in connection on the regulating motor cable.
- Pull the nest together with the regulating motor slightly to the front (1) and then lift (2). Now remove the regulating motor and the nest completely.



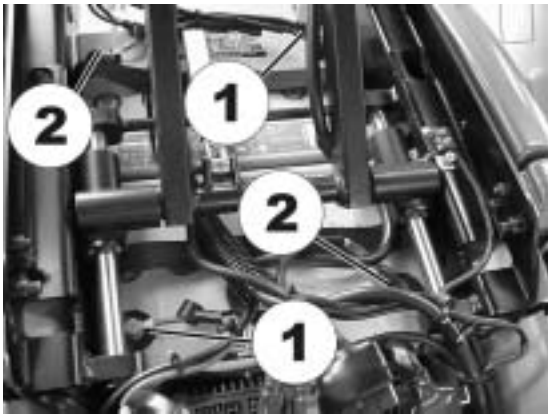
- Open the electronic panelling. In doing so, push the rear side panelling away slightly using a large, flat screwdriver.

CAUTION! Electronics can be damaged!
- *Disconnect all electronic components from the batteries before commencing work on the batteries. A short-circuit during the following work could otherwise damage the electronics.*

- Disconnect all plugs from the electronic components.

Please note
Please make a note of the cable layout. In case the cable layout is not flexible enough, the cable binders can be opened.

- Remove all pole caps from the poles.
- Unscrew the screws (1) on the minus poles using an 11mm open-jawed wrench.
- Unscrew the screws (2) on the plus poles using an 11mm open-jawed wrench.



CAUTION! Danger of crushing!
- *The batteries are very heavy. Please ensure that they do not hit the ground when being removed from the chassis.*

- Pull the battieres out to the front using the carrying belt.

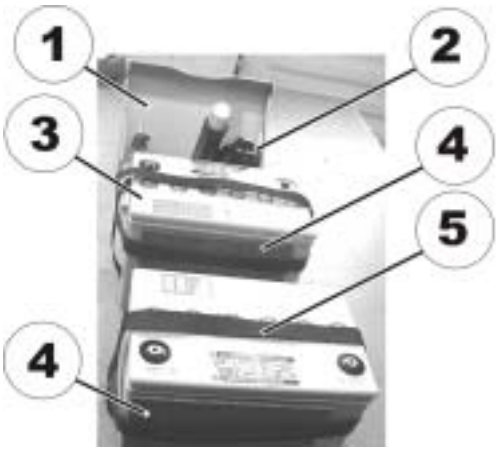
CAUTION! Fire hazard! Cables can be pinched and chafed.
- *Please ensure correct cable layout! They may not protrude into the lifter area. Use cable binders if necessary.*

- Installation is carried out in the reverse order.

Please note
The battery inserters can be inserted between the battery and the carrying belt. They are thus easier to install.

Please note
The battery poles on the rear battery must point backward and those on the front battery to the front. The batteries cannot be connected in any other fitting direction.

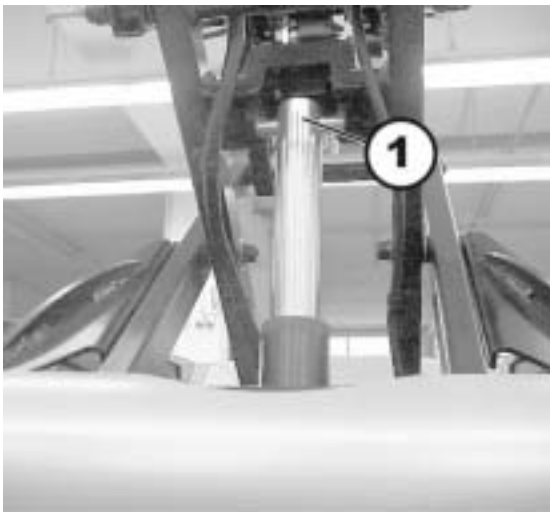
- Assemble in accordance with this installation sequence:
- Push the batteries (3) together with the carrying belt (5) and battery inserter (4) into the chassis.
- Push the regulating motor (2) together with the nest into the chassis and allow to lock into place in the bottom plate. Secure using lateral Allen screws.
- Apply the front panelling (1) and secure using lateral Allen screws.



- Screw the battery cable onto the plus and minus pole. Slide the pole caps over the poles.
- Plug all cables into the electronic components until you hear a slight click.

CAUTION! Danger of crushing!
- *Please ensure that the regulating motor slides into the upper guiding device.*

- Move the regulating motor to the uppermost position and ensure that it slides into the upper guiding device (1).



- Raise the lifter slightly and unlock the retaining mechanism (1). The entire lifter load is now on the regulating motor again.

- Test all vehicle functions.
- Check the charge status of the new batteries and charge fully.

6.4 Replacing the main fuse

If the main fuse is burnt out, then this almost certainly indicates a short-circuit in the battery cables. If the cause is not a battery cable, then there may be a short circuit inside the power module. This is very unlikely, but can occur under extreme conditions, such as when the wheelchair has been cleaned using a high-pressure cleaning device. Needless to say, using such a device against Invacare's strong recommendation not to (in the User Manual) will void the warranty.

CAUTION! Danger of fire!

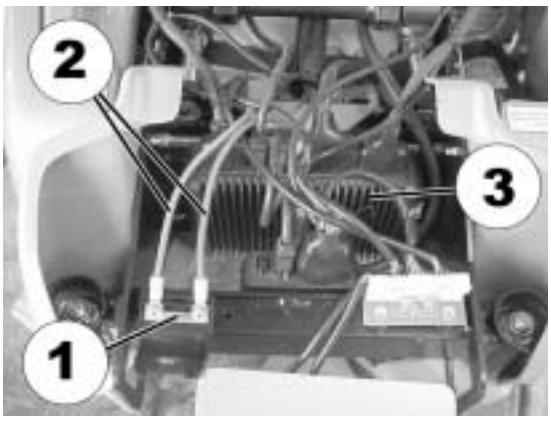
- *Only ever use a fuse with the correct value:* ***ACS System: 50 A, Shark: 40 A!***
- *If the main fuse is burnt out, then the cause must be fixed before inserting a new fuse!*

Requirements:

- Combination wrench 8mm
- Spare fuse
- Large flat-bladed screwdriver

- Use the flat-bladed screwdriver to carefully pry the rear plastic cover off, as shown in the picture.

- Open the lid of the fuse compartment (1).
- If the main fuse is burnt out, then first determine what caused this. Only when the problem has been fixed may the fuse be replaced
- Check the battery cables (2) in their entirety for damage. If damaged, replace them.
- If the battery cables are not damaged, then the cause may be a short-circuit inside the power module (3) (partially hidden by cables in the picture). This is not necessarily visible from the outside. In this case exchange the power module for another one to determine whether this is the cause.
- Loosen and remove the nuts that hold the fuse with the 8mm combination wrench.
- Insert a new fuse, re-position the nuts and tighten.
- Close the lid of the fuse compartment.



- Reassemble all parts, such as the rear cover, in reverse order.
- Test all wheelchair functions to make sure everything is working properly.

6.5 Checking the cables

Find out here how you can check the plug connections on the Tornado electronics.

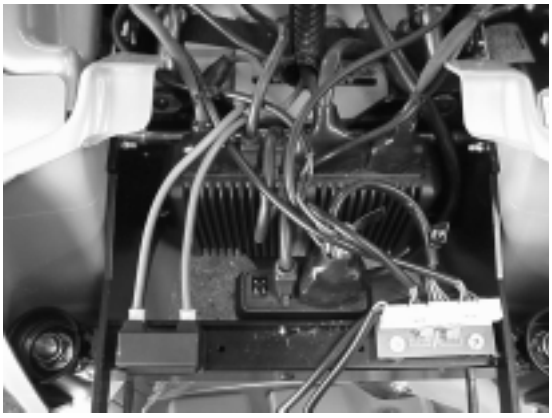
CAUTION! Cables can pull off!
- *Remove the electronic panelling carefully on vehicles with a lighting system so that the cables are not pulled off the light circuit board. The connectors do not have to be removed.*

Pre-requisites:
- Large, flat screwdriver

Please note
Use the screwdriver carefully in order to avoid scratches on the panelling

- Move the lifter to the uppermost position.
- Remove the electronic panelling. In doing so press the cover out of the rear side panelling on one side using a large, flat screwdriver.

- Check all cables for signs of damage and crushing.
- Be careful with every connector. It must not come away from the bush.
- If a connector is loose, use slight pressure to press the connector into the bush. It must lock into place.
- Check whether the connector is fitted firmly into the bush. If not, please repeat the preceding work step.



- Close the electronic panelling. In doing so, push the rear side panelling away slightly using a large, flat screwdriver.

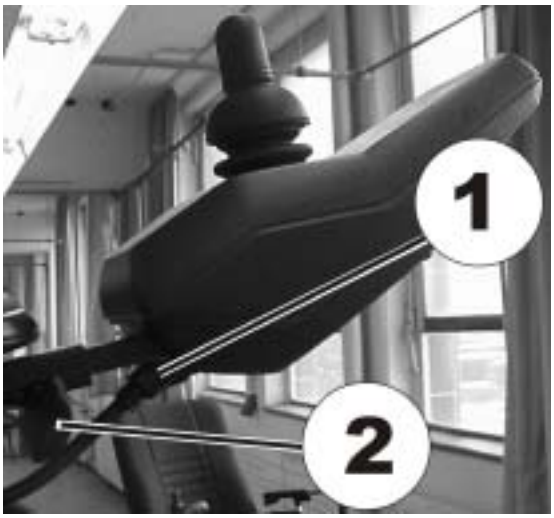
- Check all vehicle functions.

6.6 Replacing the remote

Pre-requisites:
- Crosstip screwdriver
- Wizard software or hand programming device

Please note
All remotes are supplied with a standard drive programme. This does not enable lighting and regulating motors to function. If you do not wish to re-adjust all parameters, preferably save the current drive programme before replacing the remote.

- Switch off the remote.
- Pull the bus cable (1) out of the remote.
- Loosen the thumb screw (2).
- Pull the remote and the remote holder out of the guiding device.



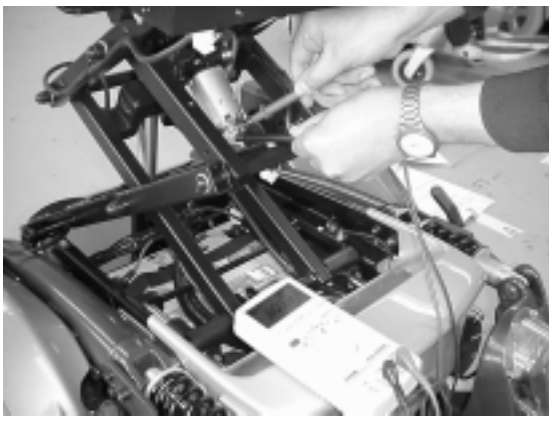
- Unscrew both remote holder screws (1) using the crosstip screwdriver.

- Installation of the remote is carried out in reverse order.
- Adapt the drive programme using the hand programming device or Wizard software or transcribe the copy onto the new remote.
- Check all vehicle functions.

6.7 Testing an actuator motor

Requirements:
- Multimeter

- Check the electrical resistance of the actuator. If it is close to infinite, then the motor is likely to be burnt out. If it is less than 1Ω, then motor has a short-circuit. In either case, the motor needs to be replaced.



6.8 Adjusting and replacing the speed reduction switch

Find out here how you can adjust and replace the switch that reduces the speed when in the upper lifter position.

Pre-requisites:
- Small pliers

- Move the lifter to the upper and lower position several times. In doing so check whether the contact switches.
- If the contact does not switch, bend the plate (1) slightly.
- If the contact is faulty, replace the entire cable harness.

- Check all vehicle functions.

6.9 Replacing the steering head bearings on the front or rear castor wheels

CAUTION! Incorrect reassembly can damage the bearings or cause the steering wheels to fall out!

- *The single-row angular ball bearing races are not the same on both sides! For this reason there is only one correct way to fit them! It is imperative that you observe the reassembly information!*

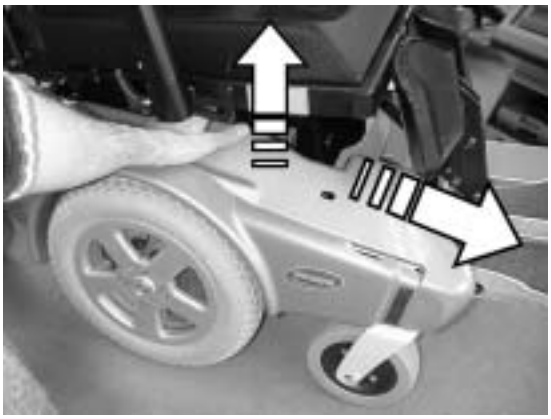
Requirements:

- Socket wrench 19 mm
- Torque wrench

6.9.1 Front Castor Wheels

- Release the plastic clips (1) that hold the shroud.

- Pull the shroud outwards and forward to remove.



- Prop the wheelchair up on the side that you want to change the bearings on by placing an object underneath the drive wheel.

- Loosen and remove the 19 mm nut using the socket wrench. Hold the wheel so it does not rotate while removing the nut.
- Pull the steering head shaft down and out of the steering head tube.
- Remove the washer and the bearing race from the top of the tube. The other bearing race should be on the shaft.

IMPORTANT REASSEMBLY INFORMATION!

The pictures show the wide rim on the outside of the bearing race (A) and the narrow rim on the inside (B).

The bearings must always be assembled so that the narrow rims are facing each other (inwards)! The steering head bolt and the nut must always press against the wide rims from the outside! Otherwise the bearings will be forced out apart by the pressure of the bolt!

The steering wheels should swivel freely after assembly, but there should be no play in the bearings.

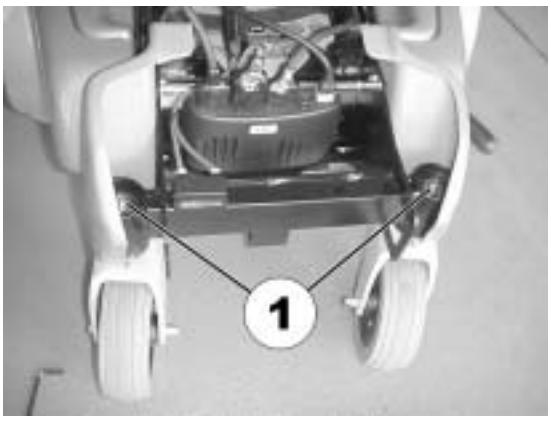
- First tighten the nut to 20 Nm +/- 2 Nm.
- Loosen the nut a little.
- Retighten to 15 Nm +/- 1.5 Nm

6.9.2 Rear Castor Wheels

- Use the flat-bladed screwdriver to carefully pry the rear plastic cover off, as shown in the picture.

- Prop up the wheelchair by lifting it up on the side that you want to work on and then placing the wooden block underneath the battery box on that side.

- Loosen and remove the 19 mm nut (1) that holds the castor wheel using the socket wrench. Hold the wheel so it does not rotate while removing the nut.
- Pull the steering head shaft down and out of the steering head tube.
- Remove the washer and the bearing race from the top of the tube. The other bearing race should be on the shaft.



IMPORTANT REASSEMBLY INFORMATION!

The pictures show the wide rim on the outside of the bearing race (A) and the narrow rim on the inside (B).

The bearings must always be assembled so that the narrow rims are facing each other (inwards)! The steering head bolt and the nut must always press against the wide rims from the outside! Otherwise the bearings will be forced out apart by the pressure of the bolt!

The steering wheels should swivel freely after assembly, but there should be no play in the bearings.

- First tighten the nut to 20 Nm +/- 2 Nm.
- Loosen the nut a little.
- Retighten to 15 Nm +/- 1.5 Nm

6.10 Replacing the Anti-Dive Spring and/or its plastic guides

CAUTION! Danger of the wheelchair tipping over or rolling away!

- *Secure the wheelchair from tipping over by propping it up with a wooden block under the battery box that is long and wide enough! Using a wooden block that is too short or too high could cause the wheelchair to tip over!*
- *Switch the wheelchair off at the remote!*

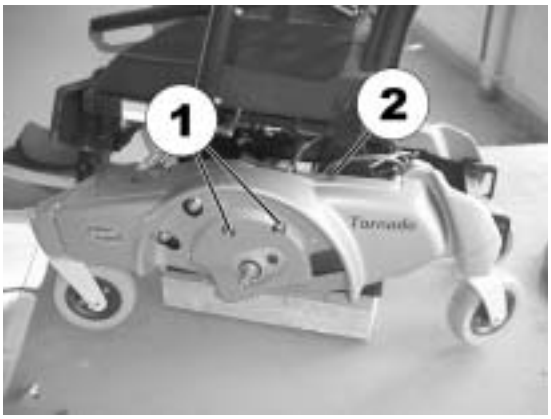
Requirements:

- 13 mm open-ended wrench
- 5 mm Allen key
- 6 mm Allen key

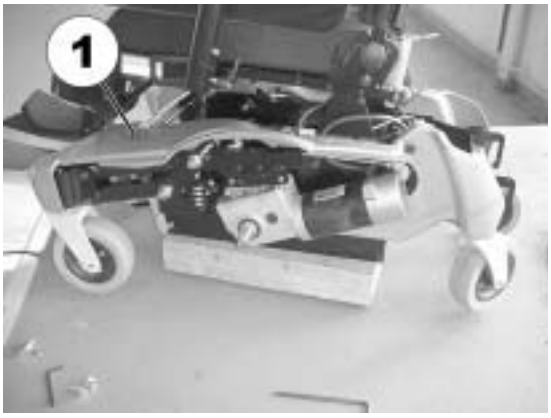
Note
Pay attention to small pieces, and the order in which the components are disassembled. Arrange them in an orderly fashion so they can easily be assembled again in the right order.

- Prop up the wheelchair by lifting it up on the side that you want to work on and then placing the wooden block underneath the battery box on that side (1).
- Use the 5 mm Allen key to loosen and remove the screw that holds the wheel (2).
- Pull the wheel off the axle.

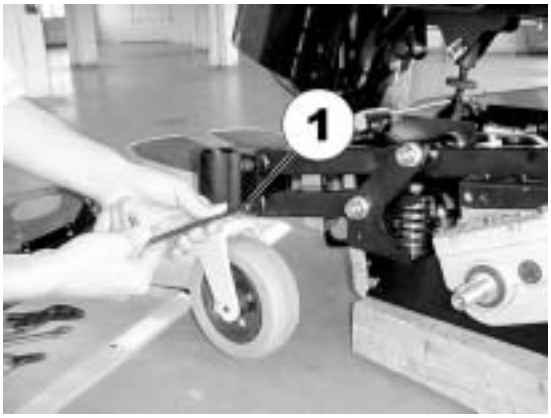
- Use the 6 mm Allen key to loosen and remove the bolts (1) that hold the outer shroud.
- Release the rear plastic clip (2) that attaches the inner and outer shrouds.
- Remove the outer shroud.



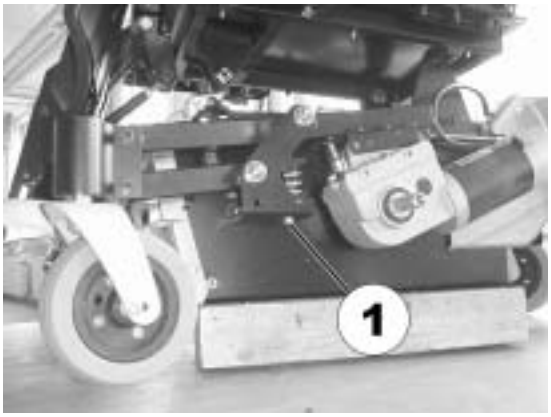
- Release the forward plastic clip (1) that holds the inner shroud.
- Remove the inner shroud.



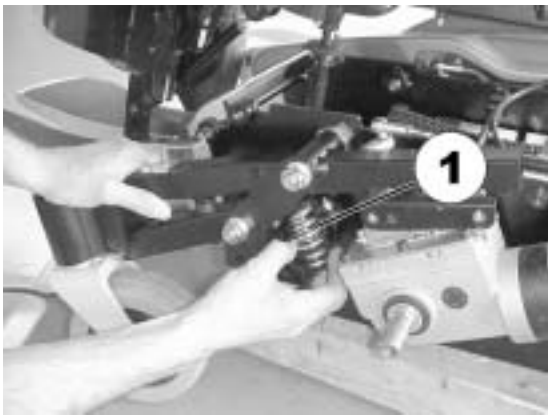
- Use the 6 mm Allen key and the 13 mm open-ended wrench to remove the lower bolt (1) that attaches the Walking Beam and the steering head tube of the front castor wheel.



- Use the 13 mm open-ended wrench to remove the bolt (1) that holds the lower plastic guide of the anti-dive spring.



- The two halves of the Walking Beam can now be moved independently from each other. Lift the upper part, which is still attached to the steering head tube of castor wheel, to release the pressure on the anti-dive spring (1).
- Replace the anti-dive spring and/or the plastic guide(s) if necessary.



- Reassembly is done in reverse order.

6.11 Repairing a flat tyre

CAUTION! Danger of the wheelchair tipping over or rolling away!

- *Secure the wheelchair from tipping over by propping it up with a wooden block under the battery box that is long and wide enough! Using a wooden block that is too short or too high could cause the wheelchair to tip over!*
- *Switch the wheelchair off at the remote!*

CAUTION! Injury hazard! If the wheel has been insufficiently tightened during assembly, it can become loosened during driving!

- *When reassembling the drive wheels, tighten the Allen screws at a torque of 30 Nm!*
- *Secure all screws using a suitable blocker (e.g. Loctite 243)!*

Requirements:

- Open-ended spanner 5 mm.
- Repair kit for tyre repair or a new inner tube.
- Talcum powder
- Screw blocker Loctite (e.g. Loctite 243)

Note
Pay attention to small pieces, and the order in which the components are disassembled. Arrange them in an orderly fashion so they can easily be assembled again in the right order.

- Prop up the wheelchair by lifting it up on the side that you want to work on and then placing the wooden block underneath the battery box on that side.

- Unscrew the 4 bolts that hold the wheel (1), using the 5mm Allen key.
- Remove the wheel from the hub.

- Unscrew valve cap.
- Depressurise tyre by pressing in the pin in the valve .
- Remove the 5 cylinder head screws (back of the wheel, 2.
- Remove the rim halves from the tyre.
- Remove the inner tube from the tyre.
- Repair inner tube and replace, or insert a new one.

NOTE
If the old inner tube is to be repaired and re-used, and has become wet during repair, you can make replacement easier by sprinkling the inner tube with a little talcum powder.

NOTE
Re-assembly is done in reverse order. Ensure that the tyre is replaced on the same side and in the same travel direction as it was previously mounted.

- Insert the wheel rim halves from outside into the tyre.
- Pump a little air into the inner tube.
- Insert the cylinder head screws in the rim and tighten the wheel rims firmly.
- Ensure that the tyre outer is seated correctly.
- Pump the tyre up to the prescribed pressure.
- Check that the tyre is seated correctly once again.
- Screw the valve cap back on.
- Refit the wheel.

6.12 Replacing a drive wheel

CAUTION! Danger of the wheelchair tipping over or rolling away!

- *Secure the wheelchair from tipping over by propping it up with a wooden block under the battery box that is long and wide enough! Using a wooden block that is too short or too high could cause the wheelchair to tip over!*
- *Switch the wheelchair off at the remote!*

Requirements:

- 5 mm Allen key

Note

Pay attention to small pieces, and the order in which the components are disassembled. Arrange them in an orderly fashion so they can easily be assembled again in the right order.

- Prop up the wheelchair by lifting it up on the side that you want to work on and then placing the wooden block underneath the battery box on that side.

- Unscrew the 4 bolts that hold the wheel (1), using the 5mm Allen key.
- Remove the wheel from the hub.

- Reassembly is done in reverse order.